Mole Conversions Worksheet

There are three mole equalities. They are:

1 mol = 6.02×10^{23} particles
1 mol = g-formula-mass (periodic table)
1 mol = 22.4 L for a gas at STP

Each equality can be written as a set of two conversion factors. They are:

$$\left(\frac{1\ mole}{6.02x10^{23}\ particles}\right) \qquad \left(\frac{6.02x10^{23}\ particles}{1\ mole}\right)$$

$$\left(\frac{1\ mole}{g-formula-mass}\right) \qquad \left(\frac{g-formula-mass}{1\ mole}\right)$$

$$\left(\frac{1\ mole}{22.4\ L}\right) \qquad \left(\frac{22.4\ L}{1\ mole}\right)$$

Mole-Particle Conversions

1. How many moles of magnesium is 3.01×10^{22} atoms of magnesium?

$$\mathbf{3.01 \times 10^{22}\ atoms}\left(\frac{1\ mole}{6.02x10^{23}\ atoms}\right) = 5 \times 10^{-2}\ \text{moles}$$

2. How many molecules are there in 4.00 moles of glucose, $C_6H_{12}O_6$?

$$\mathbf{4.00\ moles}\left(\frac{6.02x10^{23}\ molecules}{1\ mole}\right) = 2.41 \times 10^{24}\ \text{molecules}$$

3. How many moles are 1.20×10^{25} atoms of phosphorous?

$$1.20 \times 10^{25}\ \text{atoms}\left(\frac{1\ mol}{6.02 \times 10^{23}\ \text{atoms}}\right) = 19.9\ \text{moles}$$

4. How many atoms are in 0.750 moles of zinc?

$$0.750\ \text{mol}\left(\frac{6.02 \times 10^{23}\ \text{atoms}}{1\ \text{mol}}\right) = 4.52 \times 10^{23}\ \text{atoms}$$

5. How many molecules are in 0.400 moles of N_2O_5?

$$0.400\ \text{mol}\left(\frac{6.02 \times 10^{23}\ \text{molecules}}{1\ \text{mol}}\right) = 2.41 \times 10^{23}\ \text{molecules}$$

Mole-Mass Conversions

1. How many moles in 28 grams of CO_2 ?

Gram-formula-mass of CO_2 1 C = 1 x 12.01 g = 12.01 g
2 O = 2 x 16.00 g = 32.00 g
64.00 g/mol

$$\textbf{28 g } CO_2 \left(\frac{1\ mole}{44.00\ g}\right) = 0.64 \text{ moles } CO_2$$

2. What is the mass of 5 moles of Fe_2O_3 ?

Gram-formula-mass Fe_2O_3 2 Fe = 2 x 55.6 g = 111.2 g
3 O = 3 x 16.0 g = 48.0 g
159.2 g/mol

$$\textbf{5 moles } Fe_2O_3 \left(\frac{159.2\ g}{1\ mole}\right) = 800 \text{ grams } Fe_2O_3$$

3. Find the number of moles of argon in 452 g of argon.

$$452\text{g Ar}\left(\frac{1\text{mol}}{40\ \text{g}}\right)\ 11.3\text{moles Argon}$$

4. Find the grams in 1.26×10^{-4} mol of $HC_2H_3O_2$.

$$1.26\text{x}10^{-4}\text{mol}\left(\frac{60\ \text{g}}{1\text{mol}}\right) = 7.56\text{x}10^{-3}\ \text{g}$$

5. Find the mass in 2.6 mol of lithium bromide.

$$2.6\text{ mol}\left(\frac{86.8\ \text{g}}{1\text{mol}}\right) = 225.68 \text{ or } 230\ \text{g}$$
SF

Mole-Volume Conversions

1. Determine the volume, in liters, occupied by 0.030 moles of a gas at STP.

$$0.030 \text{ mol} \left(\frac{\mathbf{22.4\ L}}{\mathbf{1\ mole}} \right) = 0.67 \text{ L}$$

2. How many moles of argon atoms are present in 11.2 L of argon gas at STP?

$$11.2 \text{ L} \left(\frac{\mathbf{1\ mole}}{\mathbf{22.4\ L}} \right) = \mathbf{0.500\ moles}$$

3. What is the volume of 0.05 mol of neon gas at STP?

$$0.05 \text{ mol} \left(\frac{22.4 \text{ L}}{1 \text{ mol}} \right) = 1.12 \text{ L}$$

4. What is the volume of 1.2 moles of water vapor at STP?

$$1.2 \text{ mol} \left(\frac{22.4 \text{ L}}{1 \text{ mol}} \right) = 26.9 \text{ L}$$

Mixed Mole Conversions

Given unit → Moles → Desired unit

1. How many oxygen molecules are in 3.36 L of oxygen gas at STP?

$$3.36 \text{ L} \left(\frac{\mathbf{1\ mole}}{\mathbf{22.4\ L}} \right) \left(\frac{\mathbf{6.02x10^{23}\ molecules}}{\mathbf{1\ mole}} \right) = 9.03 \times 10^{22} \text{ molecules}$$

2. Find the mass in grams of 2.00×10^{23} molecules of F_2. 12.624 g

Gram-formula-mass 2 F = 2 x 19 g = 38 g/mol

$$2.00 \times 10^{23} \text{ molecules} \left(\frac{\mathbf{1\ mole}}{\mathbf{6.02x10^{23}\ particles}} \right) \left(\frac{\mathbf{38\ g}}{\mathbf{1\ mole}} \right) = \mathbf{12.6\ g}$$

3. Determine the volume in liters occupied by 14 g of nitrogen gas at STP.

Ans. 11.2 L

$$14\text{g } N_2\left(\frac{1\text{mol}}{28\text{g}}\right)\left(\frac{22.4\text{L}}{1\text{mol}}\right) = 11.2\text{ L}$$

4. Find the mass, in grams, of 1.00×10^{23} molecules of N_2.

Ans. 4.65 g

$$1.00\times10^{23}\text{ molecules}\left(\frac{1\text{mol}}{6.02\times10^{23}\text{ molecules}}\right)\left(\frac{28\text{g}}{1\text{mol}}\right) = 4.65\text{ g}$$

5. How many particles are there in 1.43 g of a molecular compound with a gram molecular mass of 233 g?

Ans. 3.69×10^{21}

$$1.43\text{g}\left(\frac{1\text{mol}}{233\text{g}}\right)\left(\frac{6.02\times10^{23}}{1\text{mol}}\right) = 3.69\times10^{21}\text{ particles.}$$

6. Aspartame is an artificial sweetener that is 160 times sweeter than sucrose (table sugar) when dissolved in water. It is marketed by G.D. Searle as *Nutra Sweet*. The molecular formula of aspartame is $C_{14}H_{18}N_2O_5$.

a) Calculate the gram-formula-mass of aspartame.

294 g/mol $14(12) + 18(1) + 2(14) + 5(16) = 294\text{g}$

b) How many moles of molecules are in 10 g of aspartame?

3.4×10^{-2} moles

$$10\text{g}\left(\frac{1\text{mol}}{294\text{g}}\right) = 3.4\times10^{-2}\text{ moles}$$

c) What is the mass in grams of 1.56 moles of aspartame?

458.64 grams

$$1.56\text{mol}\left(\frac{294\text{g}}{1\text{mol}}\right) = 458.64\text{g}$$

d) How many molecules are in 5 **mg** of aspartame?

1.0238×10^{19}

$$5\text{mg}\left(\frac{1\text{g}}{1000\text{mg}}\right)\left(\frac{1\text{mol}}{294\text{g}}\right)\left(\frac{6.02\times10^{23}}{1\text{mol}}\right) = 1.0238\times10^{19}\text{ molecules}$$

e) How many atoms of nitrogen are in 1.2 grams of aspartame?

4.9143×10^{21}

$$1.2\text{g}\left(\frac{1\text{mol}}{294\text{g}}\right)\left(\frac{6.02\times10^{23}\text{ molecules}}{1\text{mol}}\right)\left(\frac{2\text{ N atoms}}{1\text{molecule}}\right) = 4.9\times10^{21}\text{ atoms.}$$

Name: _____ Period: _____

Mixed Mole Problems Worksheet

Directions: Solve the following problems. Be sure to show all your work

1. Find the number of moles if there are 7.63×10^{24} molecules of a substance.

$$7.63\times10^{24}\left(\frac{1\text{ mol}}{6.02\times10^{23}}\right) = 12.7\text{ moles}$$

2. How many moles of $CaCO_3$ are there in 2.00 kg of $CaCO_3$?

$$2.00\text{ kg}\left(\frac{1000\text{ g}}{1\text{ kg}}\right)\left(\frac{1\text{ mol}}{100.1\text{ g}}\right) = 20.0\text{ moles}$$

3. What is the mass of 8.42 moles of $(NH_4)_2S$?

$$8.42\text{ mol}\left(\frac{68.1\text{ g}}{1\text{ mol}}\right) = 573\text{ g}$$

4. Find the number of carbon atoms in 18.5 g of CH_3OH (methanol).

$$18.5\text{ g}\left(\frac{1\text{ mol}}{32\text{ g}}\right)\left(\frac{6.02\times10^{23}\text{ molecules}}{1\text{ mol}}\right)\left(\frac{1\text{ atom}}{1\text{ molecule}}\right) = 3.48\times10^{23}\text{ C atoms.}$$

5. If one litre of a gas at STP has a mass of 3.17 g, what is the molar mass of this gas? Name the diatomic element that makes up this gas?

$$\frac{3.17\text{ g}}{\text{L}}\left(\frac{22.4\text{ L}}{1\text{ mol}}\right) = 71\text{ g/mol}$$

6. What volume at STP would 11.50 g of oxygen gas occupy?

$$11.50\text{ g}\left(\frac{1\text{ mol}}{32\text{ g}}\right)\left(\frac{22.4\text{ L}}{1\text{ mol}}\right) = 8.05\text{ L}$$

Name: _____ Period: _____

7. What is the mass of 33.2 L of SO_2 gas at STP?

$$33.2\text{L}\left(\frac{1\text{mol}}{22.4\text{L}}\right)\left(\frac{64.1\text{g}}{1\text{mol}}\right) = 95.0\text{g}$$

8. Based on the data from the periodic table, calculate the density of Fluorine gas at STP in g/L.

$$\frac{38\text{ g}}{\text{mol}}\left(\frac{1\text{mol}}{22.4\text{L}}\right) = 1.7\text{g/L}$$

9. Calculate the molar mass of a gas at STP, if 360.0 mL of this gas has a mass of 0.680 g

$$\frac{0.680\text{g}}{360.0\text{mL}}\left(\frac{1000\text{mL}}{1\text{L}}\right)\left(\frac{22.4\text{L}}{1\text{mol}}\right) = 42.3\text{ g/mol}$$

10. Methane has the formula CH_4. Calculate the mass of 2.75 L of this gas at STP.

$$2.75\text{L}\left(\frac{1\text{mol}}{22.4\text{L}}\right)\left(\frac{18\text{g}}{1\text{mol}}\right) = 2.21\text{g}$$

11. What is the mass of 5580.0 mL of nitrogen gas at STP?

$$5580.0\text{mL}\left(\frac{1\text{L}}{1000\text{mL}}\right)\left(\frac{1\text{mol}}{22.4\text{L}}\right)\left(\frac{28\text{g}}{1\text{mol}}\right) = 6.975\text{g}.$$

12. How many atoms of bromine are there in 175.0 mL of bromine gas at STP?

$$175.0\text{mL}\left(\frac{1\text{L}}{1000\text{mL}}\right)\left(\frac{1\text{mol}}{22.4\text{L}}\right)\left(\frac{6.02\times10^{23}\text{ molecules}}{1\text{mol}}\right)\left(\frac{2\text{ Br atoms}}{1\text{molecule}}\right) = 9.406\times10^{21}\text{ atoms}$$

13. How many molecules of CO_2 are there in 2.57 L of this gas at STP.

$$2.57\text{L}\left(\frac{1\text{mol}}{22.4\text{L}}\right)\left(\frac{6.02\times10^{23}\text{ molecules}}{1\text{mol}}\right) = 6.91\times10^{22}\text{ molecules}.$$

Percent Composition Worksheet

1) What is the percent composition of nitrogen in $AgNO_3$?

$$\frac{14g}{102} \times 100 = 14\%$$

2) What is the percent composition of carbon in C_2H_5O?

$$\frac{2(12g)}{2(12g)+5(1g)+1(16g)} \times 100 = 53\%$$

3) What is the percent composition of hydrogen in H_2SO_4?

$$\frac{2(1g)}{2(1g)+1(32.1g)+4(16g)} \times 100 = 2\%$$

4) What is the percent composition of sulfur in sulfur hexafluoride? SF_6

$$\frac{32.1g}{1(32.1g)+6(19g)} \times 100 = 22\%$$

5) What is the percent composition of iron in iron (II) sulfide? FeS

$$\frac{1(55.8g)}{1(55.8g)+1(32.1)} \times 100 = 63\%$$

6) What is the percent composition of lithium in lithium phosphate? Li_3PO_4

$$\frac{3(6.9g)}{3(6.9g)+1(31g)+4(16g)} \times 100 = 0.05\%$$

Name_____

Date_____Pd____

Empirical Formulas Worksheet, #1

Directions: Find the empirical formula and name for each of the following.

1. A compound is 24.7% Calcium, 1.2% Hydrogen, 14.8% Carbon, and 59.3% Oxygen. Write the empirical formula and name the compound.

Calcium $24.7g\left(\frac{1mol}{40.1g}\right) = \frac{0.6159}{0.6159} = 1$

Hydrogen $1.2g\left(\frac{1mol}{1g}\right) = 1.2000 = 2$

Carbon $14.8g\left(\frac{1mol}{12g}\right) = 1.2333 = 2$

Oxygen $59.3g\left(\frac{1mol}{16g}\right) = 3.7062 = 6$

$CaH_2C_2O_6$ or $Ca(HCO_3)_2$

Calcium bicarbonate

2. A compound is 21.20% Nitrogen, 6.06% Hydrogen, 24.30% Sulfur, and 48.45% Oxygen. Write the empirical formula and name the compound.

$21.20g\,N\left(\frac{1mol}{14g}\right) = \frac{1.5143}{0.7570} = 2$

$6.06g\,H\left(\frac{1mol}{1g}\right) = \frac{6.060}{0.7570} = 8$

$24.30g\,S\left(\frac{1mol}{32.1g}\right) = \frac{0.7570}{0.7570} = 1$

$48.45g\,O\left(\frac{1mol}{16g}\right) = \frac{3.028}{0.7570} = 4$

$N_2H_8SO_4$ or $(NH_4)_2SO_4$

Amonium sulfate

3. A compound is 44.82% Potassium, 18.39% Sulfur, and 36.79% Oxygen. Write the empirical formula and name the compound.

$44.82g\,K\left(\frac{1mol}{39.1g}\right) = \frac{1.1463}{0.5729} = 2$

$18.39g\,S\left(\frac{1mol}{32.1g}\right) = \frac{0.5729}{0.5729} = 1$

$36.79g\,O\left(\frac{1mol}{16g}\right) = \frac{2.2994}{0.5729} = 4$

K_2SO_4

Potassium sulfate

4. A compound is 52.0% Zinc, 9.6% Carbon, and 38.4% Oxygen. Calculate the empirical formula of the compound.

$52.0\,g\,Zn\left(\frac{1\,mol}{65.4}\right) = \frac{0.7951}{0.7951} = 1$

$9.6\,g\,C\left(\frac{1\,mol}{12\,g}\right) = \frac{0.80}{0.7951} = 1$

$38.4\,g\,O\left(\frac{1\,mol}{16\,g}\right) = \frac{2.4}{0.7951}\ 3$

$ZnCO_3$

5. A compound is 92.2% Carbon and 7.76% Hydrogen. The formula mass of the compound is 78.1 g. Calculate the empirical formula and molecular formula of the compound.

$92.2\,g\,C\left(\frac{1\,mol}{12\,g}\right)\ \frac{7.6833}{7.6833} = 1$ $\quad CH$

$7.76\,g\,H\left(\frac{1\,mol}{1\,g}\right) = \frac{7.76\,mol\,H}{7.6833} = 1$

$\frac{78.1\,g}{13} = 6$

C_6H_6

6. A compound is 43.7% Phosphorus and 56.3% Oxygen. The formula mass of the compound is 284 g. Calculate the empirical formula and molecular formula of the compound.

$43.7\,g\,P\left(\frac{1\,mol}{31\,g}\right) = \frac{1.4097}{1.4079} = 1 \times 2$

$56.3\,g\,O\left(\frac{1\,mol}{16\,g}\right) = \frac{3.5188}{1.4079} = 2.5 \times 2$

P_2O_5

$\frac{284}{142} = 2$

P_4O_{10}

7. In an experiment, it was found that 11.775 g of Sn combined with 3.180 g of O. Write the empirical formula and name the compound that is formed. 16/5

$11.775\,g\,Sn\left(\frac{1\,mol}{118.}\right) = \frac{0.09979}{0.09979} = 1$

$3.180\,g\,O\left(\frac{1\,mol}{16\,g}\right) = \frac{0.19875}{0.09979} = 2$

SnO_2

Tin II Oxide

8. A compound contains 21.6% Na, 33.3% Cl, and 45.1% O. Write the empirical formula and name the compound that is formed.

$21.6\,g\,Na\left(\frac{1\,mol}{23\,g}\right) = \frac{0.9391}{0.9380} = 1$

$33.3\,g\,Cl\left(\frac{1\,mol}{35.5\,g}\right) = \frac{0.9380}{0.9380} = 1$

$45.1\,g\,O\left(\frac{1\,mol}{16\,g}\right) = \frac{2.8188}{0.9380} = 3$

$NaClO_3$

Sodium Chlorate

9. A compound is 19.3% Na, 26.9% S, and 53.8% O. Its formula mass is 238 g. What is its molecular formula?

$19.3\,g\,Na\left(\frac{1\,mol}{23\,g}\right) = \frac{0.8391}{0.8380} = 1$

$26.9\,g\,S\left(\frac{1\,mol}{32.1\,g}\right) = \frac{0.8380}{0.8380} = 1$

$53.8\,g\,O\left(\frac{1\,mol}{16\,g}\right) = \frac{3.3625}{0.8380} = 4$

$\frac{238}{119} = 2$

$NaSO_4$

$Na_2S_2O_8$

Sodium Sulfate

10. An experiment uses a catalyst that is 23.3% Co, 25.3% Mo, and 51.4% Cl. What is the empirical formula of the compound?

$23.3\,g\,Co\left(\frac{1\,mol}{58.9\,g}\right) = \frac{0.3956}{0.2637} = 1.5 \times 2$

$25.3\,g\,Mo\left(\frac{1\,mol}{95.94\,g}\right) = \frac{0.2637}{0.2637} = 1 \times 2$

$51.4\,g\,Cl\left(\frac{1\,mol}{35.5\,g}\right) = \frac{1.4479}{0.2637} = 5.5 \times 2$

$C_3Mo_2Cl_{11}$

.2 Chemistry Molecular formula Worksheet Name _____

1. Benzene, a non-polar solvent used for many applications in industry, and a major component in many organic compounds has the following percent composition:

C = 92.3% H = 7.8 %

$92.3g\ C\left(\frac{1mol}{12g}\right) = \frac{7.6917}{7.6917}$

a. Find Benzene's empirical formula.

$7.8g\ H\left(\frac{1mol}{1g}\right) = \frac{7.8}{7.6917}$ mol H

CH

b. Find the Molecular formula of benzene if the entire formula mass is 78.12 g/mol

$\frac{78.12}{} = 6$ C_6H_6

2. An unknown sugar is found to have a formula mass of 180.18 g/mol. The sugar contains:

40.0 % C, 6.7 % H and 53.3 % O.

a. Find the empirical and molecular formula of this sugar. b. What's its name?

CH_2O = EF

$40g\left(\frac{1mol}{12g}\right) = \frac{3.33}{3.33}$ $6.7g\left(\frac{1mol}{1g}\right) = \frac{6.7}{3.33}$ $53.3g\ O\left(\frac{1mol}{16g}\right) = \frac{3.33}{3.33}$

$\frac{180}{30} = 6$

$C_6H_{12}O_6$ Glucose.

3. Tryptophan – the chemical in turkey that is believed to make you sleepy – has the empirical formula $C_{11}H_{12}N_2O_2$.
Find the molecular formula if the formula mass is 204.25 g/mol.

$\frac{204.25}{204} = 1$ Empirical and molecular are the same.

4. Caffeine is made of 49.48 % C, 5.19% H, 16.48% O and 28.8% N. Find the molecular mass of Caffeine if its overall molecular mass is 194.22 g/mol

C_2H_8N

$49.48g\ C\left(\frac{1mol}{12g}\right) = \frac{4.123}{2.057} = 2$ $16.48g\left(\frac{1mol}{1g}\right) = \frac{16.48}{2.057} = 8$ $28.8g\ N\left(\frac{1mol}{14g}\right) \frac{2.057}{2.057} = 1$

$C_8H_{32}N_4$ $\frac{194.22}{46} = 4$

5. Hydrogen peroxide is 5.93 % H and 94.07 % O. Find the formula of hydrogen peroxide given it has an overall formula mass of 34 g/mol.

$5.93H\left(\frac{1mol}{1g}\right) = \frac{5.93}{5.879} = 1$ $94.07g\ O\left(\frac{1}{16g}\right) = \frac{5.879}{5.879} = 1$

$HO = 17$

$34/17 = 2$ So H_2O_2

6. A strong oxidizing agent and rocket propellant has a % composition of 30.43% N and 69.57 % O. Find the molecular formula if its formula mass is 92.0 g/mol.

NO_2

$30.43\ N\left(\frac{1mol}{14g}\right) = \frac{2.174}{2.174} = 1$ $69.57g\ O\left(\frac{1}{16g}\right) = \frac{4.348}{2.174} = 2$

So N_2O_4 $\frac{92}{46} = 2$